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1983
ONTARIO FISHERIES
TECHNICAL REPORT SERIES
NO. 9

Ministry of
Natural
Resources
Ontario

ONTARIO FISHERIES TECHNICAL REPORT SERIES

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Ontario Ministry of Natural Resources

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ABSTRACT

Baccante, D., and J. Sandhu. 1983. Annulus Formation and Growth Characteristics of Tagged Walleye in a Lightly Exploited Lake. Ont. Fish. Tech. Rep. Ser. No. 9: i & 5 p.

A total of 135 tagged walleye *(Stizostedion vitreum vitreum)* were recaptured after two years: 43 fish (32%) had laid down the expected two scale annuli, 61 (45%) had laid down only one, and 31 (23%) had laid down none.

Scale annulus formation occurred more frequently in younger, faster-growing fish. The rate of annulus formation decreased sharply in fish that were 7 years old and older, coinciding with the approximate age at which all Savanne Lake walleye are mature and somatic growth rates decrease.

Some management implications of age-assessment errors resulting from failure to form scale annuli are discussed.

Keywords: scale annulus formation, aging, management implications, *Stizostedion vitreum vitreum*.

ANNULUS FORMATION AND GROWTH CHARACTERISTICS OF TAGGED WALLEYE IN A LIGHTLY EXPLOITED LAKE

INTRODUCTION

Failure to form scale annuli because of slow growth has been documented for brown trout *(Salmo trutta)*, brook trout *(Salvelinus fontinalis)* and rainbow trout *(Salmo gairdneri)* (Alvord 1953), largemouth bass *(Micropterus salmoides)* (Bennett 1948), European perch *(Perca fluviatilis* L.) (Alm 1946), walleye *(Stizostedion vitreum vitreum)* (Forney 1962), bluegills *(Lepomis macrochirus)* (Regier 1962), carp *(Cyprinus carpio)* (Frey 1942), and yellow bass *(Rocais mississippiensis)* (Buchholz and Carlander 1963).

This paper describes growth retardation, measured by the failure to form scale annuli, among tagged walleye. Measurements were taken during a study to determine annual production and dynamics of a lightly exploited population in Savanne Lake, Ontario (Sandhu 1979). The possibility of failure of scale annulus formation for the entire population is explored, as are the possibilities of drawing erroneous conclusions if some of the insights presented herein are ignored.

METHODS AND MATERIALS

Savanne Lake (48°49'N 90°06'W) is situated approximately 128 km northwest of Thunder Bay, Ontario, at the headwaters of the Savanne River, which flows into Lac des Mille Lacs (Sandhu 1979).

This study was conducted during 1973, 1974 and 1976. Walleye were captured using 1.22 m (4 ft.), 1.83 m (6 ft.), and 2.44 m (8 ft.) trapnets. The fish were measured and weighed, and scale samples were taken. Then the fish were tagged by attaching a numbered oval Floy tag (Model FTF 69) with monofilament line of 2.7 kg test strength. The monofilament line was inserted, using a 5.08 cm long curved needle, through the anterior-most part of the pterygiophore below the soft dorsal. All walleye were released at their respective sites of capture. Upon recapture, the tagged fish were again measured and weighed, and scale samples collected.

The ages of the fish were determined by counting the annuli visible on scale impressions made on cellulose acetate slides. Scale impressions were read, using an Eberbach scale projector at 40X magnification, on two different occasions by the same reader. The criteria used to define the annuli are described by Lagler (1956) and Calhoun (1966).

RESULTS

In the spring of 1976, 135 of the walleye which had been tagged in the spring of 1974 were recaptured. The number of fish which had laid down two, one, and zero annuli were 43 (32%), 61 (45%), and 31 (23%), respectively (Table 1).

The probability of forming annuli was much lower in the older age groups and appears to be correlated with changes in total length between time of tagging and recapture (Table 1).

Averaged over all age groups, fish which had formed zero, one, and two annuli during the two-year period increased in total length by 4, 9, and 19 mm respectively (Table 2).

DISCUSSION

Failure of the tagged walleye to lay down the expected number of annuli may be a direct result of growth retardation. Alvord (1953), De Roche (1963) and Smith et al (1951) assiciated the failure of other fish species to lay down annuli with little or no increase in total length. These authors attributed the minimal growth to the effects of the type of tag used, a jaw-tag.

Although growth retardation due to tagging was difficult to assess in this study, because of the small sample of tagged fish recovered during the three study years, it was not believed to be significant in light of the findings reported by Moenig (1975). Using the same type of tag and tagging method as this study, Moenig found no significant differences in growth increments between tagged and untagged walleye.

The failure of Savanne Lake walleye to form scale annuli probably is not limited to tagged fish. Linear growth is greatly retarded in the older age groups of walleye in this lake (Sandhu 1979). Nikolskii (1969) suggested that older fish use limited food supplies primarily for maintenance and maturation, rather than growth. In Savanne Lake, some walleye do not reach maturity until age eight for males and age nine for females. Therefore, it is expected that only a relatively small amount of energy goes towards linear growth after the fish reach maturity.

Age structure data from trapnet catches show a "piling-up" of fish considered to be eight years old and younger (Fig. 1). This suggests that many Savanne Lake walleye may not lay down a recognizable annulus every year after age eight. As a result, an overestimate of the number of age eight and younger fish, and an underestimate of the number of older fish, may occur.

Failure to form scale annuli because of slow growth has been documented by a number of authors. Casselman (1978) provided a thorough literature

Table 1. Number of walleye tagged in 1974 and recaptured in 1976 which laid down 2, 1, or 0 scale annuli during the 2-year period. The mean increments in length during the same period of time are also shown.

Scale Age at Release (1974)	N	Number of Recaptured Fish that Formed:			Mean Number of Annuli Formed per Year	Mean Increment in Length (mm)
		2 Annuli	1 Annulus	0 Annuli		
4	3	3	0	0	1.00	+34
5	25	18	7	0	0.86	+16
6	22	20	2	0	0.95	+17
7	13	1	8	4	0.38	+ 5
8	62	1	40	21	0.34	+ 8
≥ 9	10	0	4	6	0.20	- 1
	Σ 135	43	61	31		

Table 2. Changes in mean total lengths and number of scale annuli added between time of tagging and recapture, for Savanne Lake walleye.

Scale Age at Tagging	N	Mean length at time of tagging (1974) (mm)	Mean length at time of recapture (1976) (mm)	Number of annuli added	Mean changes in total length (mm) for each annulus formed		
					0	1	2
4	3	343	377	2	-	-	+34
5	7	381	396	1	-	+15	-
	18	374	391	2	-	-	+17
6	2	384	393	1	-	+ 9	-
	20	392	410	2	-	-	+18
7	4	432	432	0	0	-	-
	8	432	438	1	-	+ 6	-
	1	373	391	2	-	-	+18
8	21	435	441	0	+ 6	-	-
	40	432	441	1	-	+ 9	-
	1	404	416	2	-	-	+12
9	4	421	421	0	0	-	-
10	1	445	449	0	+ 4	-	-
	4	437	435	1	-	- 2	-
11	1	462	457	0	- 5	-	-
	135				$\Delta\bar{L}$ +4	+ 9	+19
					N 31	61	43

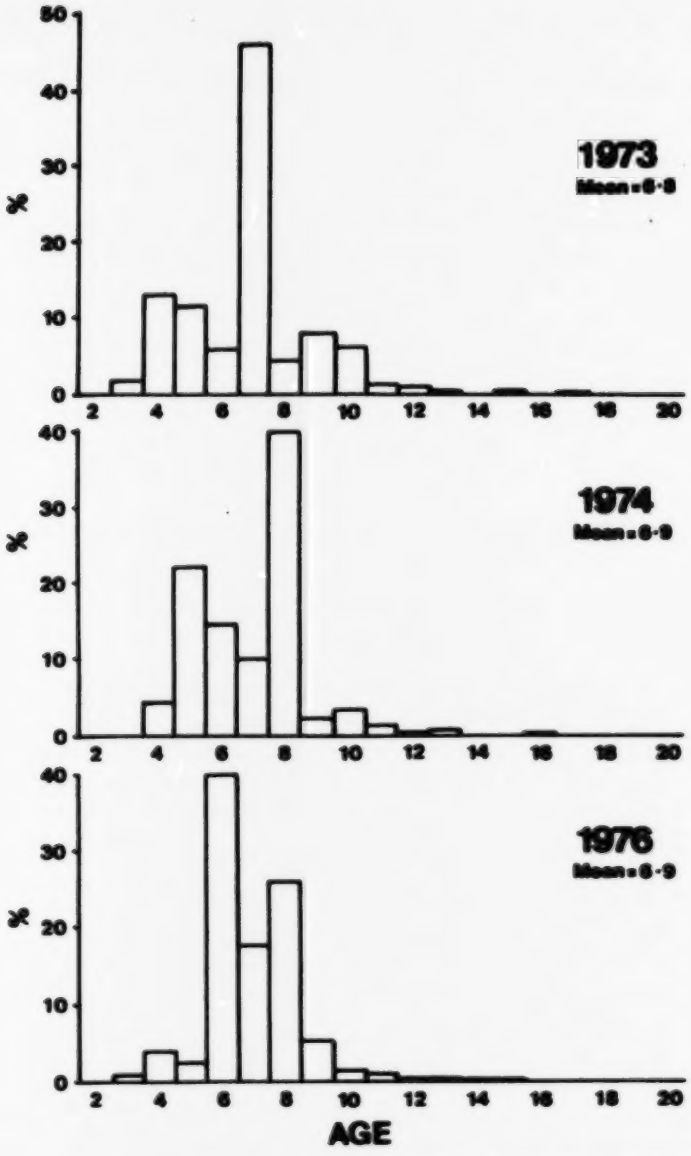

Figure 1. Age distributions, as determined from Schumacher-Eschmeyer population estimates, of the walleye population in Savanne Lake during the three study years.

review of the subject, along with results from his own laboratory and field work. Mraz (1968) compared actual annual increments in length to expected annual increments for walleye tagged for 1 and 2 years in Pike Lake. He found similar growth retardation in that population, with smaller, faster-growing fish showing the least effects.

Erickson (1979) correlated the non-formation of scale annuli in walleye to conditions of slow growth, the latter being determined by exploitation levels. He concluded that scale annuli were adequate in assessing the ages of fast-growing populations, but recommended that bony structures be used for slow-growing ones, when possible.

Current studies on walleye and yellow perch *(Perca flavescens)* in Henderson Lake indicate that annulus formation on scales is not occurring at the expected rate (unpublished data). Controlled exploitation experiments which may, among other things, change growth rates and the rate of annulus formation are currently being conducted on this research lake.

Other studies have shown that length measurements may be affected by frayed distal portions of caudal fins, caused by handling (Eschmeyer

and Crowe 1955). Very few fish in Savanne Lake exhibited this condition, therefore it was not considered a source of error.

MANAGEMENT IMPLICATIONS

In any study of stunted or slow-growing fish populations, the possibility of failure of scale annulus formation should be considered. Management decisions may be incorrect if scale annuli have not been laid down or if they are unrecognizable because of slow growth, either as a result of tagging or high population density. For example, an underestimate of the number of annuli may lower age-specific exploitation rates as a result of underestimating the number of fish in older age groups.

Gulland (1955) described some theoretical considerations of the effects of errors in age reading on various parameters such as mortality and survival. Kohler and Clark (1958), in an aging study of haddock *(Melanogrammus aeglefinus)*, noted an artificial increase in the numbers of fish in younger year classes(ages 4 and 6), and a resultant decrease in the number of 7 year olds, as a result of aging errors.

In an aging study of lake whitefish *(Coregonus clupeaformis)*, Mills and Beamish (1980) suggested that scale aging may lead to erroneous conclusions re annual survival and growth of lightly or unexploited populations. They concluded that scale ages might show an increase in length at age for young age groups as harvest increased. The impact on older age classes could not be determined because the fish which were removed were initially underaged. This aspect of growth should be of particular interest to walleye managers of northern boreal lakes, where there is good potential for reproduction, greater longevity and, possibly, greater competition for food than in southern lakes (Peter J. Colby, personal communication).

Scales have been described as being less reliable for aging walleye than other bony structures, such as dorsal spines (Campbell and Babaluk 1979). This is particularly true in slow-growing populations where scale ages should be verified by other methods, when possible.

In conclusion, the authors of this report do not mean to suggest that age determinations from scale readings are not useful; but rather, that caution should be taken in the interpretation of scale annuli data when studying slow-growing populations.

ACKNOWLEDGEMENTS

The authors are grateful to Peter J. Colby, Fisheries Research, Thunder Bay, for suggesting and initiating this research, and for his continuous criticisms. We also wish to thank John Casselman, Al McCombie and Andy Lawrie, Fisheries Research, Maple, Ontario; Scott Campbell, Fisheries and Oceans, Winnipeg; and Tom Osborn, Minnesota Department of Natural Resources, for their helpful criticisms on earlier versions of this report. Appreciation is also extended to Letizia Tamasi, for typing the manuscript.

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